THE INCIDENCE AND PROPHYLAXIS OF HUMAN TRYPANOSOMIASIS IN NORTH EASTERN RHODESIA

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When the Expedition to the Congo returned to England in the autumn of 1905, Dr. Todd stated that there was reason to fear an extension of human trypanosomiasis from the Congo Free State into British territory. This statement was based principally on the facts that the disease was spreading steadily southwards, that imported cases of sleeping sickness existed practically on the borders of Rhodesia, at Moliro and Baudoinville on Lake Tanganyika, and that one of the main trade routes ran from this lake to Nyassa. The history of the spread of the disease in the Congo showed that it had been carried from point to point along the main caravan roads, often with startling rapidity.

In the following year, reports were received that an imported case existed at the Belgian post of Kasenga on the Luapula River, and in September, 1906, Dr. Todd and one of us were informed by Mr. F. W. Arnott, of the Garanganza Mission, that cases were present at Lukafu on the Lufira River. In November, Dr. Todd received from Dr. Massey, then of the Tanganyika Concessions, Limited, a communication stating that the disease was endemic in the villages around Lake Kisale and some of its confluents, and further, that about 9 per cent. of the carriers from Kabinda to Ruwe were infected. (When Dr. Todd went through this part of the Congo, he found that about 13 per cent. of the people in the neighbourhood of Kabinda were infected, but that fish sellers from the South, whom he saw there, were free from the disease.) In about a year and a half then, June

1905 to November 1906, the disease had become endemic around Lake Kisale, having been imported from Kabinda. As loads were constantly being brought to the Katanga mines from these infected areas, the greatest danger existed that foci of the disease would be established there, especially as Dr. Massey had found tsetse flies (*Gl. palpalis* and *Gl. morsitans*) in the immediate vicinity of some of them. Most of the labour for these mines had been recruited in British territory, so that the gravest fears were entertained that the disease would be carried into Rhodesia by some of these men on returning to their homes. Finally, about the same time a report reached home that the disease was invading the Western shores of Lake Mweru.

In consequence of this knowledge, representations were made to the Colonial Office by the Authorities of the School, pointing out the danger of trypanosomiasis being carried into British territory, and asking for support for an expedition which it was proposed to send to the threatened districts to study more fully the local conditions. At the same time the British South Africa Company were asked to assist, as North-Eastern Rhodesia would probably be the first to suffer. This proposition was eventually accepted, and the present expedition sent out. Broken Hill was reached on June 16, 1907, and shortly afterwards one of us left for Fort Jameson.

The following report, it will be understood, does not discuss the situation fully, as we have seen but a small portion of the country. It is believed, however, that enough evidence has been accumulated to judge of the probable occurrence of human trypanosomiasis, and also to judge the value of the various measures which have been suggested for combating the disease.

ROUTE

On the accompanying map the route followed to date will be found, and also those areas of North-Eastern Rhodesia in which species of *Glossina* are known to occur. This information, of course, is not complete at present. So far as possible the main roads were followed, as it is along these that experience has taught us the disease is usually carried. As we went from village to village, all the inhabitants were palpated, and in those cases in which it was possible, gland puncture was performed. This enabled us to control the value

of gland palpation as a means of diagnosis so far as a country was concerned in which the disease was supposed to be non-existent. Most attention has been devoted to the Luapula division, as large numbers of natives from this district have worked in the Katanga, and as, in the natural course of events, it would be the first portion to be invaded. The other area from which the disease was expected to enter Rhodesia was along the border between Mweru and Tanganyika. As yet we have not been able to visit this part, but evidence is accumulating that the prediction made by Dr. Todd is in course of fulfilment.

DISTRIBUTION OF TSETSE FLIES

A. In North-Eastern Rhodesia.

1. *Glossina palpalis.* In brief, we now know that this species exists along a large part of the Luapula and some of its confluents; on the shores of Lake Mweru; and around the southern end of Lake Tanganyika.

It was first found in 1906 by Dr. Noble at Kasenga and the Nafunta Falls on the Congo side of the Luapula. This year it was found by Dr. Spillane along this river from Kapwepwi's to Kasiwa's village, and along the British portion of the two lakes. We have been able to confirm these observations as regards the Luapula. It was also found by Dr. Spillane for some distance up the Mansa and Kalungwisi rivers, and we have found it up the Luongo a short distance from its mouth.

Along the portion of the river mentioned above, the bush extends right to the margin of the water, where it assumes a more luxuriant growth and affords abundant shade. From Chongola's to Sakontwi, the river is bordered by wide flats almost completely destitute of vegetation. From Sakontwi to Kapwepwi's the shore is fringed by a single, more or less continuous, row of bushes and small trees which project obliquely outward over the water. Behind this there is a bare, treeless strip of ground varying in width from 25 to 200 yards, and beyond this again the ordinary thin bush of the country begins. This lack of continuous shade behind the river and the small amount of shelter afforded by the fringe of bushes probably account for the absence of *Gl. palpalis.* From Kasiwa's to Mweru, the conditions are

somewhat similar except that swamps, one to five miles wide, replace the dambos. This fly, *Gl. palpalis*, is most readily found by paddling just along the trees which line the shore, and success often follows this manœuvre when a search on the shore itself has been fruitless. As a rule, the fly will not come out to the canoe if very far from the shore, although occasionally we have noticed it at a distance of from 100 to 150 yards. As has been observed before, we have found it to be most active in the middle portion of the day when the sun is shining brightly. Early in the morning and late in the evening are unfavourable hours to look for it. We have also been able to confirm the observation made in Uganda[1] that the fly is absent from those portions of the shore where the trees are replaced by grass and water weeds for any distance.

2. *Glossina morsitans*. While we use this specific name, we wish it to be understood that the identification of our specimens is not complete, so that in addition to *Gl. morsitans* proper, the closely related *pallidipes* may exist. This will be discussed more fully at a later date.

This fly has an extremely wide distribution, not in definitely defined belts, such as are said to be found farther South, but more or less generally scattered over the whole country. For the purposes of this report it is not necessary to give all the situations in detail: it will suffice to say that it is found in most of the districts in greater or lesser numbers. While these areas are marked on the map, it must not be concluded as yet that they are not present in the unmarked portions.

Like *Gl. palpalis*, we have found them to increase in activity as the sun approaches the zenith, and to be fewer in number and less voracious on dull days. Their activity is maintained well on towards sunset, and we have noticed an occasional one flying into the tent after this time. Water and shade are not such necessary factors to this fly as to *palpalis*. We have observed it at least three miles from water, and have been informed by one of the officials that he has seen it ten miles from water. The amount of shade afforded by the thin type of bush peculiar to the country is very small, in the dry season practically none. A certain amount of shelter is required, however, as this fly is not found on the open dambos which break the continuity of the bush.

The consensus of opinion throughout Rhodesia is that tsetse flies are steadily increasing in numbers, regions which only a few years ago were free being now heavily infested by species of the genus, i.e., with *Glossina morsitans* and possibly *pallidipes*. This increase cannot be ascribed to a corresponding increase in game, since large areas exist where game is practically absent and tsetse flies abound, while in other parts the reverse holds good.

B. In the Nyassaland Protectorate.

Glossina palpalis has not been found here, but other species are known. *Gl. fusca* has been observed in the Karonga district, and again in the neighbourhood of Chiromo. *Gl. pallidipes* was found in the former area, and *Gl. morsitans* is present in various parts of the country.

C. In the Katanga District of the Congo Free State.

1. *Glossina palpalis.* From Dr. Massey we learn that this fly occurs on the West shore of Mweru; at the junction of the Dilukwe and Lufira rivers; at Nkoni Hill on the Lufira; on the Lukulegi river near the Congo-Zambesi watershed; at Busanga, junction of the Lufupa and Lualaba (tin mines); on the South Kaluli, at the cut road crossing from Ruwe to Mazanguli's; on the Lualaba, from the Kalenga Falls to Chisamba; on the Inje river, running into Lake Kisale.

2. *Glossina morsitans.* In the whole region bounded by the Lualaba and Lufira; along the road from Kambove to Madona; in the neighbourhood of Busanga; on the Lubudi river, and at its junction with the Mkuleshi; on a line drawn from Ruwe to Kansanshi, in two places.

The disease is endemic in this part of the Congo along the Lualaba, from its junction with the Lubudi to its point of exit from Lake Kisale, and on the Lufira around the Government post of Kayumba and at its junction with the Dilukwe. Moreover, the whole of the Lufira from Kisale to Mwenda's village, a short distance from the Nkoni Hill Mission and the local administrative post of Lukafu, is suspected. We have also mentioned above that imported cases of the disease were present at Nkoni Hill in September, 1906.

GLAND PALPATION AND PUNCTURE

Since Greig and Gray[2] noted that trypanosomes were fairly constantly present in the enlarged glands of persons suffering from trypanosomiasis, the efficiency of this means of diagnosing the disease in its earlier stages has been repeatedly demonstrated. Dutton and Todd[3] were the first to recognise its practical importance, and their experience led them to make the statement that 'every negro with enlarged glands must be considered, until the contrary is proved, to be a case of human trypanosomiasis.' Koch[4] confirmed the value of the method in the course of his work, and more recently the British investigators in Uganda have done the same.

As compared with other means of detecting the disease, in the absence of definite symptoms, gland puncture is infinitely the best. This has been shown so clearly and so often that no stress need be laid on it here. While enlargement of the glands does not occur with unfailing regularity in every case, the number of these is so comparatively small that it does not invalidate the practical utility of the method nor the prophylactic measures based on its application.

In obtaining our results, we have used the classification adopted by Dutton and Todd.[5] This schedule is arbitrary, and is one into which the personal equation enters to a large degree, but the exact determination of the class in which the enlarged glands should be placed, e.g., '+—' or '+——,' is perhaps of more academic than practical value. Our figures are based on the palpation of the glands in the posterior triangle of the neck.

In the six months, July-December, 1907, some 9,005 natives were examined, and of these 1,878 had palpable glands, a percentage of 20·85, classified as follows:—

+	+ −	+ − −
5	36	1837

Expressed as percentages of the total number of enlarged glands, we have:—

+	+ −	+ − −
0·26	1·91	97·81

or as percentages of population (based on number examined):—

+	+ −	+ − −
0·05	3·99	23·99

The majority (5,000) were from villages closely bordering the Luapula, but the results from various other districts visited were much the same, so that these figures may be accepted as a fair index of the occurrence of enlarged glands throughout the whole country.

In as many cases as was practicable, gland puncture was performed and the juices thus obtained examined microscopically. The results were:—

Class	Number Palpated	Number Punctured	Number Infected	% of successful punctures
+	5*	5	3	60
+ −	36	30	0	0
+ − −	1837	297	0	0

From this table it will be seen that in the '+—' and '+——' groups the result was uniformly negative, while of the five '+' cases, three harboured trypanosomes.

These findings point to the conclusions that slight enlargement of the glands commonly occurs unassociated with trypanosomiasis, and that excessive enlargement, in practice, means 'sleeping sickness.' By this we mean that such cases should certainly be regarded with suspicion, and should be isolated until puncture can be performed by a properly qualified person. The number of positive cases we have seen is altogether too small to permit of any dogmatic statement as to how great a percentage of '+' glands, in this country, harbour the parasites.

As regards Nyassaland, a report sent to us before leaving England shows that of 3,467 natives examined in various parts of that

* One of these, a child 4 years old, had only one gland, measuring 2×1 cm. There was no apparent cause for the enlargement.

territory, 26 had ' + ' glands, 409 ' + —,' and 1,406 ' + ——.' We have no knowledge of any of these having been punctured, so that we are not in a position to say whether any are infected. Judging, however, from our results in Rhodesia, some of the negroes with ' + ' glands might quite possibly be cases of the disease. While these figures are given as the results of the palpation of the glands in the posterior triangle of the neck, one of us was informed by one of the medical men concerned in collecting the figures that glands in all parts of the neck were included. If this is the case with all, the figures would need to be corrected, since some of the glands, e.g., the submaxillary and suboccipital, are very frequently enlarged, from causes other than trypanosome infection.

It therefore seems clear from the relative frequency of slight glandular enlargement, and the uniformly negative findings on puncture, that the axiom 'glands mean trypanosomes' needs to be revised, so far, at least, as Rhodesia and Nyassaland are concerned. It might be stated that excessive enlargement of the glands, sufficiently marked to bring them into the ' + ' category, must be regarded as meaning trypanosomiasis until the opposite has been proved. The practical meaning is that a medical officer is the only person who can satisfactorily apply the method of palpation. This will be considered in more detail below.

OCCURRENCE OF CASES OF TRYPANOSOMIASIS

Three cases of the disease were found in the Luapula division. At the time at which they were first seen, all appeared to be in perfect health, and presented no other signs of the disease than glandular enlargement. In all of them, the glands in the posterior triangle of the neck were the only ones which had increased in size. In the village of one of the cases *Gl. morsitans* was present, but only the one case was found. All had a history of having worked in the Katanga mines some three to four years previously. When it is remembered that human trypanosomiasis is commonly very insidious in its onset, and that cases may remain free from symptoms for years, there can be little doubt that these cases originated in the district mentioned. Contributory evidence that this view is correct is afforded by the fact that no indigenous case was found in any of the

villages along the Luapula, although *Gl. palpalis* is present and the people constantly exposed to their bites. The infection can be clearly traced, then, from Kabinda to Lake Kisale, from there southwards to some of the Katanga mines,* and from these again it has been brought into Rhodesia.

As regards the Northern portions of the country around Mweru and Tanganyika, we have at present no personal experience, but there is reason to believe that cases also exist there. These would not necessarily be introduced from the Katanga although the possibility of this must not be overlooked. Very large numbers of natives from these districts have worked in the mines, and since cases have occurred amongst those who went from the Luapula division, there is just as much reason to expect that cases will be found in all the districts from which labour has been drawn. The other point of introduction would be from the endemic centres along the higher reaches of the Luapula, and from Lake Tanganyika. In 1901, imported cases were present at Moliro,[6] in 1902, at Baudoinville, and within the last year the disease has been reported as being endemic in the vicinity of Vua. As fly exists (*Gl. palpalis*) along the shores of Mweru and Tanganyika, as the people have been communicating freely, and as there have been numbers of Swahili traders crossing from one country to the other with their retinues, cases of the disease might reasonably be looked for. There is good reason to believe that these are present.

All these points bear out in a striking manner the correctness of Dutton and Todd's[6] observations on the way in which the disease has been carried from an infected to a non-infected region.

TRANSMISSION OF THE DISEASE

Wherever sleeping sickness has been found, its distribution has been closely related to that of *Glossina palpalis*. This has been accepted as showing more or less conclusively that the disease can only be transmitted by this species. While it would be idle to ignore the inferences implied by this relationship of the disease and *Gl. palpalis*, there is little foundation for the belief that this fly only is

* At present there are a number of cases of human trypanosomiasis in the hospital at Ruwe, and until very recently, at all events, at Kambove as well.

responsible for the spread of the disease, in the light of our present knowledge.

In parts of the Congo Free State visited by the Expedition of this School to the Congo, the disease was found to be widely disseminated, although *Gl. palpalis* was found only very scantily Since, therefore, the numbers of this fly did not appear to account for the number of cases, experiments[7] were made with various other biting Arthropods—the larva of *Auchmeromyia luteola* (Congo Floor Maggot), *Ornithodoros moubata*, *Simulium* and Anophelines—to transmit *Trypanosoma gambiense*. All these resulted negatively The experiments to transmit by means of tsetse flies were also unsatisfactory, and although positive results were obtained, the number of flies required was so great that it was felt the solution had not been reached. In Uganda,[8] the results were similar Large numbers of flies were required for success, and this only followed when the interval between the 'infecting' and the 'transmitting' feed did not exceed 48 hours. No satisfactory evidence of a developmental cycle of the trypanosome in tsetse flies has yet been obtained, and it can now be accepted as proved that transmission by mechanical means is possible. The importance of this is self-evident Mechanical transmission does not explain satisfactorily the rapid extension of the disease which has been observed in many instances. nevertheless, whether it is eventually shown that the trypanosomes do pass through a cycle in the tsetse fly analogous to that observed in the case of so many other parasitic protozoa, and that *Glossina palpalis* is the natural transmitter of the disease, the practical importance of this accidental, or mechanical, transmission by other species of the genus cannot be overlooked.

In a report sent in to the Administration of North-East Rhodesia in 1906, Dr. Noble states that Dr. Polidori, of the Congo service, told him that their experience led them to believe that *Gl morsitans* had to be incriminated as well as *Gl. palpalis*. Arguing by analogy from the work on cattle trypanosomiasis, this is what would be expected. As is well known, Ngana is ordinarily spread by *Gl. morsitans* (and probably *pallidipes*) yet successful transmission experiments have been carried out with a Tabanid;[9] and other trypanosomes, naturally transmitted by one species or other of the genus *Glossina*, have been carried from animal to animal by distinct

species of the same genus and such entirely different ones as *Stomoxys*[8] and *Tabanus*. While arguing by analogy is often a fallacious method, some proof that in this particular instance it can be accepted is afforded by the recent demonstration in Uganda that *Trypanosoma gambiense* can be transmitted by *Gl. fusca*.[10]

This question of exactly what species of biting flies, more particularly tsetse, are capable of transmitting human trypanosomiasis is one of the most important which still remains to be decided in connection with this disease. If it can be shown that *Glossina palpalis* is directly responsible for the spread of the disease and that the other species are only accidental carriers, the work of controlling the extension will be very much simplified and the cost greatly lessened. This is a point which merits attention from all the Governments concerned.

In brief, our knowledge as to the transmission of the disease stands thus—

1. The only known method of transmission is mechanical.
2. *Gl. palpalis* and *Gl. fusca* can transmit the disease.
3. At present all other species of *Glossina* must be regarded with equal suspicion.

PROPHYLAXIS

The whole system of prophylaxis is based on the application of gland palpation and puncture. Since by this means we are enabled to detect the disease in its earliest stages in over 97 per cent. of the cases, we are in a position to weed out the infected and isolate them before they have become very dangerous. It is manifest that as long as the trypanosomes are confined to the glands, as opposed to the peripheral blood circulation, the chances of a tsetse fly becoming infected are comparatively small. Koch[11] has also stated that the tsetse flies he employed only became infected when animals were used which had had the disease for a considerable length of time, and in whose blood the parasites were scanty. From this it will be seen that the value of gland palpation is enhanced so far as prophylactic measures are concerned. These measures may be divided into two broad sections—1 major, and 2 minor measures.

1. MAJOR MEASURES.

These are—A. Control of native movements.
B. Segregation of cases.
C. Removal of villages from dangerous zones.

2. MINOR MEASURES.

A. Clearing.
B. Education of the natives.
C. Personal prophylaxis.
D. Destruction of tsetse flies, their larvae and pupae.

1. MAJOR MEASURES.

A. Control of native movements.

Of their own accord, natives do not move about the country in large bands. These are either directly associated with Europeans, Swahili, and Arab traders, or indirectly under their control. Legislation to control the direction of these movements would accordingly do much to prevent the importation of cases from infected to non-infected areas. This legislation should make it an offence, punishable by suitable fines, for any person having infected natives in his employ, taking natives from a non-infected region to an infected one and vice versâ, or otherwise violating the regulations promulgated from time to time with regard to sleeping sickness.* Wherever possible it would be well to have all natives who are travelling for any distance certified as free from symptoms of the disease by a competent person.

In the case of North-East Rhodesia, the only dangerous movements are from Madona to the Katanga mines, and the operations of the Swahili trader along the northern border. We believe that the cases we have found originated at the Katanga mines; in addition there are cases under treatment at Ruwe, and until very recently at Kambove as well; and tsetse flies exist along the whole of the route from Madona to Kambove. The danger of this traffic was pointed out as long ago as February, 1907, and the stoppage of labour-recruiting for the mines was then advised. This, however, was not done until later in the year, when the receipt of reports from Dr. Sheffield Neave, in addition to those previously sent

* That some such legislation is required is shown by the fact that although Madona is now the only place at which the Luapula can officially be crossed, white men have on several occasions crossed the river higher up after leaving that place

in by Dr. Massey, made it plain that the disease was steadily gaining ground in the southern portions of the Congo Free State. Permission has been given to the Tanganyika Concessions, Limited, to recruit labour in British territory to transport the loads now lying at Madona (6,000 odd), and those actually in transit in the country, to the mines. We are of the opinion that this policy is mistaken, and that the Tanganyika Concessions should be required to take the loads across the Luapula and find the necessary carriers in the Congo Free State.

On the West, Rhodesia is separated from the Congo Free State by a boundary which can be watched with comparative ease, viz., the Luapula river. With exception of fords at the Mombatuta Falls, at Madona and at the Johnston Falls, the river can only be crossed in canoes, and when the river is in flood these fords are impassable. The measures suggested, therefore, to protect the river are the confiscation of all canoes and the placing of patrols at the fords should this be found necessary. To render these measures absolutely effective, the co-operation of the Congo Government will have to be obtained, for if the villages on that side of the river are allowed to retain their canoes, it would nullify to a great degree the benefit derived by the confiscation of the canoes on the British side. If the mining companies in the Katanga refused to give work to any natives of Rhodesia who might get across the river, the general mass of natives would soon learn that it was useless to go to the mines, and the temptation to leave their villages would thus be removed. In addition any uninfected natives of British territory who are in the Katanga at present should be returned immediately.

The operations of the Swahili traders are chiefly confined to the northern border. The obvious way of dealing with them is to refuse licenses and to require them to leave the country absolutely. Regulations to this effect have been passed. The control of a land boundary, especially in a country like Africa, cannot be perfectly effected, but by the stoppage of organised traffic much can be done. Eventually it may be necessary to establish a patrol along the border between Mweru and Tanganyika, but the utility of moving all the villages from a strip parallel with the boundary might first be considered. If practicable, it would do more to stop communication than any system of surveillance, however complete. Here co-operation with the Congo authorities would be advisable.

Another region which requires attention is that part of the boundary between North-East Rhodesia and the Congo State extending from the Luapula to North-West Rhodesia. One of us was informed by Mr. Croad, the Native Commissioner at Serenje, that the Congo Free State claimed the territory twenty miles to the East of the true boundary, and that in this debated land the Katanga mines are recruiting labour. Until the boundary dispute is settled, the British and Congo authorities should unite in forbidding any recruiting to be done in the country in question.

Along the frontier between North-West Rhodesia and the Congo Free State no natives are now supposed to cross, and as the country along this border is very sparsely populated there is not much violation of this regulation. The most important point is that all loads going to the Katanga mines have to be carried from the frontier by labour recruited in that territory. As we have pointed out above, this should also be the case in North-East Rhodesia.

With respect to Nyassaland, no labour is now allowed to proceed to the Katanga. While this is so, it must not be forgotten that there are there a number of skilled workmen and raw labourers from this country, and these will be returning to their homes at future dates. It is an open question whether some of those who have already gone home have not already carried the infection into the Protectorate, just as has occurred in the case of Rhodesia. In a recent number of the British Medical Journal,[12] we notice that the Principal Medical Officer of Nyassaland does not anticipate the entrance of the disease from the North, and even if this be so, a point on which we still have some doubts, the possibility of it coming in by the route mentioned above must not be ignored. As *Gl. fusca* occurs in the Protectorate, and as it is capable of transmitting the disease, the danger which may result from the introduction of human trypanosomiasis is apparent. The chief line of trade from the North end of Nyassa is from Karonga to Kasama, in Rhodesia. So far as is known at present there is no danger connected with this, though odd cases of the disease, imported from the Katanga, may exist in the neighbourhood. Whether there is any danger of it coming in from German East Africa, we cannot say. Imported cases were present at Udjidji in 1906, and *Gl. palpalis* is found along the German shore of Tanganyika to below Bismarckburg.

B. Segregation of cases.

This is a most necessary precaution. Cases of trypanosomiasis exist in the country and tsetse flies are widely distributed, in one instance, at least, being fairly plentiful in the village in which an infected man was living. The practical application of gland palpation and puncture are the means to be adopted in finding the cases. Dutton and Todd[5] pointed out that any European, or even intelligent native, could apply the method. While it cannot be doubted this is possible, it would be advisable not to rely on the chance assistance of either of these. Even with the best of intentions, the majority of Europeans would not fully appreciate the importance of the issues involved, and would soon tire of practising it. A dependence on results thus obtained would only lead to a false sense of security. Again, the fact that enlarged glands in this country does not necessarily mean trypanosomiasis is another reason why the work should be left in the hands of trained medical officers. The saving of time where palpation and puncture can be done on the spot, and the consequently lessened danger of having possibly infected people travelling through the country to the nearest medical officer, are facts worthy of consideration. At the present date it appears probable that cases are scattered over a wide area of the territory; therefore we would suggest that a sufficient number of special medical officers be appointed to travel systematically through all the villages palpating all the natives and puncturing those in which this was indicated. In the event of cases being discovered, they should at once be removed to a segregation camp for treatment. Before leaving their villages, or, in fact, as soon as the diagnosis had been established, they should be given a full dose of atoxyl, preferably intravenously. This would drive the trypanosomes from the peripheral circulation—Koch[13] states for at least 30 days—and would prevent the possibility of infected persons acting as disseminators of the disease on their way to the camp.

It must not be thought that one visit to a village will be sufficient. Two of the cases we found only escaped earlier detection by reason of the fact that they were absent from their villages when these were first visited.

The districts into which the country is divided for this purpose should not be so large as to make it impossible for the medical officer

to do the work satisfactorily. The villages should be visited at least twice a year, though oftener would be much preferable and advisable. Too much work would be entailed if one medical officer were expected to do all this travelling, and in addition look after a segregation camp. To provide two medical men for each sleeping sickness district would perhaps be too expensive, though if the political divisions (in North-Eastern Rhodesia) are adhered to, this number would be required. In North-Eastern Rhodesia the cases will be found chiefly along the frontier, and it would be quite possible to have one central segregation camp somewhere on the plateau which would serve the requirements of the whole Northern portion of the country. This would have to be under a resident doctor.

It must be admitted that this scheme will entail a substantial expenditure, but the cost will only be a fraction of the loss which would result from a wide-spread extension of sleeping sickness, and in addition there is a fair chance of success if put into operation at once. Another point is that the expenditure would probably not be a permanent drain on the country, as when all the cases have been found and isolated, and when the frontiers have been finally closed, the staff could be reduced. As more knowledge is obtained of the bionomics of tsetse flies, of the fate of trypanosomes ingested by them, and of what flies are capable of transmitting the disease, other methods of controlling its spread may be found.

In Nyassaland the disease is unknown at present, though there is a possibility of it being in the country already.

C. Removal of villages from dangerous zones.

As long as villages are left in places where tsetse flies abound, the introduction of a case of trypanosomiasis is dangerous. We quite recognise that it will be impossible to carry this measure into effect everywhere, but in situations where *Gl. palpalis*, at least, exists, it should be put into application. In other cases clearing must be resorted to. In Rhodesia, this measure would apply to those villages lying along the Luapula, Mansa, Luongo and Kalungwisi rivers and Lakes Mweru and Tanganyika. Whether it can be done in all these situations we cannot say, but with regard to the Luapula, the Mansa and the Luongo it is practicable, and in fact is being enforced. In most cases these particular villages only settled on the river after the

advent of British rule had ensured peace; formerly they were further back in the hills, and it is to these former sites that they are being moved. This procedure will also lessen the chance of natives crossing the river surreptitiously.

2. Minor Measures.

A. Clearing.

In those cases in which the villages cannot be moved, the surrounding land must be cleared. The extent to which this must be done appears to be variable. Dutton and Todd advise 300 yards, while in Uganda, Dr. Hodges[1] states that a break of 50 yards (in the case of *Gl. palpalis*) is sufficient to banish them from their natural haunts. In this connection Madona affords a striking example. On either side of the ferry, the whole shore has been absolutely cleared for a distance of 200 yards. Beyond this again the land is planted with gardens for some distance (about 500 yards to the East and 700 to the West). From the river's edge the clearing extends back for 350 yards, and in the middle of this clearing, some 225 yards from the river, the various residences and offices are placed. The river here is over 400 yards in width. It will thus be seen that the clearing more than satisfies the most exacting demand that has yet been made, but in spite of its extent, specimens of *Gl. palpalis* have been seen and caught on at least half a dozen occasions on the verandahs of some of the buildings, and this too when there was no possibility of them having been accidentally carried from the bushy part of the shore. We would, therefore, consider it more advisable to move villages from fly-infested locations than to leave them in small clearings. The native is notoriously lazy and careless, and even if forced to make clearings, would allow them to grow up again unchecked unless continuously supervised. In cases where villages have to be left, we would insist on the 300 yard clearing as the very smallest that should be allowed.

B. Education of the natives.

The relationship existing between tsetse flies and sleeping sickness should be explained to the chiefs, and the importance of placing their villages in fly-free country. So far as Rhodesia is concerned, most of the natives know from practical experience that cattle and sheep

invariably die when brought into contact with 'tuzembe,' and would therefore appreciate the importance of giving these insects a wide berth. At present sleeping sickness is unknown to the natives, and unless controlled they would not be deterred from pursuing such occupations as fishing, by an abstract fear of a disease of which they know nothing. The ordinary bush tsetse (*Gl. morsitans*) is known to most of them, as mentioned, but they are not so well acquainted with *palpalis*. The chiefs might be asked to notify any case of unusual illness in their villages and to clear the bush around the places where water is drawn. No reliance, however, could be placed on their promises to carry out any regulations.*

C. Personal prophylaxis.

This is obviously directed to the prevention of the bites of tsetse flies. Adequate clothing and the use of some of the means adopted in the prophylaxis of malaria would be applicable here, e.g., head nets where the fly are very bad.

D. Destruction of tsetse flies.

Unfortunately we know of no means of directly destroying them. Very little is known of the bionomics of these insects, so that we are in the dark as to their most vulnerable point. So far as our experience goes, burning the veldt does not make much difference in the number of flies. Indirect measures of banishing them, such as clearing, have been mentioned above.

In brief then, the measures we would suggest for adoption in Rhodesia are—

1. The absolute and immediate closure of the Luapula.
2. The stoppage of transport from Madona to Kambove by natives of Rhodesia.
3. The return of all uninfected natives of Rhodesia, and Nyassaland, from the Katanga mines to their homes.
4. The various mining companies in the Katanga should be requested to refuse work to any native of Rhodesia.
5. The Rhodesian and Congo Governments should refuse permission to recruit labour in disputed territory.

* For instance, the chiefs along the river have been told that they must not take anyone, white or black, across, yet in spite of this such cases have come under our own observance.

6. All the canoes along the Luapula river should be seized.

7. All Arab and Swahili traders should be expelled from the country.

8. All villages on either side of the Mweru-Tanganyika boundary should be moved back, if possible.

9. Should it be impossible to carry No. 8 into effect, the establishment of patrols must be considered. This would, however, not be so satisfactory.

10. Legislation should be passed to deal with any infringements of the regulations promulgated with regard to sleeping sickness.

11. The Government of the Congo Free State should be requested to co-operate actively with the Administration of Rhodesia in rendering any measures effective which may be adopted from time to time for the protection of the frontiers.

12. That special medical officers be appointed to travel through the country to search for cases of the disease.

13. That a central segregation camp, under a resident doctor, be established in a district free from fly.

14. That all villages be moved, wherever possible, from the vicinity of tsetse flies, more particularly *Glossina palpalis*.

15. In cases where removal is impossible, clearings round the villages at least 300 yards in width should be insisted on.

16. The chiefs should be instructed with regard to the disease, its relationship to tsetse flies, and the importance of keeping the villages in fly-free country.

Madona, *February 1st*, 1908.

In a letter dated Madona, February 13th, 1908, Dr. Kinghorn refers to the official report of Dr. Spillane. . . . . He states that the report verifies what Dr. Todd prophesied in 1906. He also states that *Gl. morsitans*, as a possible transmitter of the disease, is ignored in drawing up preventive regulations.

'Another case of sleeping sickness has been found in the vicinity of Madona. This man, a chief named Matanda, says he has never been in the Congo since Europeans came into the country. His village is not far away from two others in which cases have been found.

'He has been a very big man, over six feet in height and well-developed. Now he is very much emaciated, can only rise when assisted, and walks with difficulty. Has no headache or other symptoms. Glands + — —, and on puncture show trypanosomes. These are also present in the peripheral blood. The case was diagnosed by Dr. Storrs, M.O., and I found trypanosomes in the blood.'

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